

"Relations all the way"  
means what?



## What are Tables?

Tables are just a form of Structured Data Representation, popularized by Spreadsheets (as Grids) and SQL-Compliant Database Management Systems (DBMS) where Entity Relationships Types are represented as Records in a Table.

Each Table Name identifies a Relational Set (Relation) operated on by a given SQL-Compliant DBMS.

## What is Comma Separated Values (CSV)?

A Structured Data Interchange format (created by IBM) for Data Export and Import across Database Management Systems (DBMS) that operate on Entity Relationships represented as Records in a Table.

A majority of modern SQL-compliant DBMS products support this interchange format.



## What are RDF Graphs?

An RDF Sentence is a 3-part structure comprising a Subject, Predicate, and Object that represents Entity Relationship Types grouped by Sentence Predicate.

Each Predicate identifies a Relational Set (Relation) operated on by a given RDF-Compliant DBMS (or Store).

# What are RDF Notations & Document Types?

As an Abstract Data Definition Language, RDF is expressible using a variety of notations. Examples include:

- RDF-Turtle Notation
- RDF-JSON Notation
- JSON-LD Notation
- others

Data expressed using various RDF Notations can be transformed and persisted to a number of Document Content Types. Examples include:

- text/turtle
- application/json
- application/ld+json

## What is Relational Table to RDF Graph Transformation?

How Entity Relationship Types represented as Records in a Table are transformed into Entity Relationship Types represented as RDF-based Subject, Predicate, Object sentences grouped by Predicate.

### For Example:

CSV to RDF Document transformation results in RDF-based Entity Relationship Graphs that manifests as the following document content-types: "text/turtle" (RDF-Turtle), "application/json" (RDF-JSON), and "application/json+ld" (JSON-LD), etc..



# CSV to RDF Transformation Exercise

# Demonstration, Step 1 — Open Document of Interest

Furthermore, each entity class is accompanied by three sets of statistics files (downloadable as .zip below): *Summary Statistics*, *Column Distribution* and *Table Statistics*. Each of these files contains statistics about different dimensions of the table set of the specific class:

- The **Summary Statistics** files contain summary statistics about the tables set, such as overall number of tables, overall number of rows, median rows per table and also information about row distribution in the form of quantile borders.
- The **Column Distribution** files contain an overview over the columns and their percentual occurrence across all tables of that entity class, similar to [Table 5](#).
- The **Table Statistics** files contain a list of all tables. For each table, the file reports the number of rows, the number of columns as well as the density of each column. The table statistics file allows you to identify all tables of a class containing a specific column, e.g. all tables containing a GTIN column, or all tables containing a phone number column having a minimum density of 80%.

Class	Top 100	Minimum3	Rest	JSON sample	CSV sample	Statistics Files
Product	<a href="#">top100</a>	<a href="#">minimum3</a>	<a href="#">rest</a>	<a href="#">sample_json</a>	<a href="#">sample_csv</a>	<a href="#">statistics</a>
Person	<a href="#">top100</a>	<a href="#">minimum3</a>	<a href="#">rest</a>	<a href="#">sample_json</a>	<a href="#">sample_csv</a>	<a href="#">statistics</a>
LocalBusiness	<a href="#">top100</a>	<a href="#">minimum3</a>	<a href="#">rest</a>	<a href="#">sample_json</a>	<a href="#">sample_csv</a>	<a href="#">statistics</a>
CreativeWork	<a href="#">top100</a>	<a href="#">minimum3</a>	<a href="#">rest</a>	<a href="#">sample_json</a>	<a href="#">sample_csv</a>	<a href="#">statistics</a>
Event	<a href="#">top100</a>	<a href="#">minimum3</a>	<a href="#">rest</a>	<a href="#">sample_json</a>	<a href="#">sample_csv</a>	<a href="#">statistics</a>
Place	<a href="#">top100</a>	<a href="#">minimum3</a>	<a href="#">rest</a>	<a href="#">sample_json</a>	<a href="#">sample_csv</a>	<a href="#">statistics</a>
Restaurant	<a href="#">top100</a>	<a href="#">minimum3</a>	<a href="#">rest</a>	<a href="#">sample_json</a>	<a href="#">sample_csv</a>	<a href="#">statistics</a>
Recipe	<a href="#">top100</a>	<a href="#">minimum3</a>	<a href="#">rest</a>	<a href="#">sample_json</a>	<a href="#">sample_csv</a>	<a href="#">statistics</a>
JobPosting	<a href="#">top100</a>	<a href="#">minimum3</a>	<a href="#">rest</a>	<a href="#">sample_json</a>	<a href="#">sample_csv</a>	<a href="#">statistics</a>
Hotel	<a href="#">top100</a>	<a href="#">minimum3</a>	<a href="#">rest</a>	<a href="#">sample_json</a>	<a href="#">sample_csv</a>	<a href="#">statistics</a>
MusicRecording	<a href="#">top100</a>	<a href="#">minimum3</a>	<a href="#">rest</a>	<a href="#">sample_json</a>	<a href="#">sample_csv</a>	<a href="#">statistics</a>
Book	<a href="#">top100</a>	<a href="#">minimum3</a>	<a href="#">rest</a>	<a href="#">sample_json</a>	<a href="#">sample_csv</a>	<a href="#">statistics</a>
MusicAlbum	<a href="#">top100</a>	<a href="#">minimum3</a>	<a href="#">rest</a>	<a href="#">sample_json</a>	<a href="#">sample_csv</a>	<a href="#">statistics</a>
Movie	<a href="#">top100</a>	<a href="#">minimum3</a>	<a href="#">rest</a>	<a href="#">sample_json</a>	<a href="#">sample_csv</a>	<a href="#">statistics</a>
GeoCoordinates	<a href="#">top100</a>	<a href="#">minimum3</a>	<a href="#">rest</a>	<a href="#">sample_json</a>	<a href="#">sample_csv</a>	<a href="#">statistics</a>



# Demonstration, Step 2 — Discover, Transform, and Present Knowledge Graph

Statement Collection #9	Entity
<b>Attributes</b>	_:b0
<a href="#">#row_id</a>	0( <a href="#">xsd:integer</a> )
<a href="#">#name</a>	Goldline Coloured Card White.Gcc3220 Pk25
<a href="#">#offers</a>	{ "category": "Paper", "sku": "329235", "description": "The Goldline Plain White Card uses heavy 210gsm card stock that is ideal for sturdy, long-lasting posters and artwork. It is also suitable for copiers and laser printers to create large format printouts. The card comes in a size between A1 and A2 - 500 x 700 mm - great for eye-catching displays and posters.", "pricecurrency": "GBP" }
<a href="#">#description</a>	null
<a href="#">#sku</a>	null
<a href="#">#url</a>	null
<a href="#">#brand</a>	{ "name": "Goldline" }
<a href="#">#page_url</a>	<a href="https://webstore.astute.uk.com/goldline-coloured-card-white-gcc3220-pk25/pi/329235-110250-1.html">https://webstore.astute.uk.com/goldline-coloured-card-white-gcc3220-pk25/pi/329235-110250-1.html</a> ( <a href="#">xsd:anyURI</a> )
<b>Statement Collection #10</b>	_:b1
<b>Attributes</b>	1( <a href="#">xsd:integer</a> )
<a href="#">#name</a>	UNCONDITIONAL long shirt with centre back tail split in silver grey light tencel shirting
<a href="#">#offers</a>	{ "description": "UNCONDITIONAL SS16 long shirt with centre back tail split in silver grey light tencel shirting, features a concealed button placket and contrast black buttons * Also available in black Colour : silver grey Product code : SH605 Care instructions : Dry clean recommended, wash separately in warm water, iron medium, tumble dry medium, do not bleach.", "price": "£169", "pricecurrency": "GBP" }
<a href="#">#description</a>	null
<a href="#">#sku</a>	null
<a href="#">#url</a>	<a href="https://www.unconditional.uk.com/products/unconditional-long-shirt-with-centre-back-tail-split-in-silver-grey-light-tencel-shirting">https://www.unconditional.uk.com/products/unconditional-long-shirt-with-centre-back-tail-split-in-silver-grey-light-tencel-shirting</a>
<a href="#">#brand</a>	null
<a href="#">#page_url</a>	<a href="https://www.unconditional.uk.com/products/unconditional-long-shirt-with-centre-back-tail-split-in-silver-grey-light-tencel-shirting">https://www.unconditional.uk.com/products/unconditional-long-shirt-with-centre-back-tail-split-in-silver-grey-light-tencel-shirting</a> ( <a href="#">xsd:anyURI</a> )
<b>Statement Collection #11</b>	_:b2
<b>Attributes</b>	2( <a href="#">xsd:integer</a> )
<a href="#">#name</a>	Q-Connect Epson T1291 Remanufactured Black Inkjet Cartridge C13T12914011 / T129140
<a href="#">#offers</a>	{ "category": "Printer Supplies#Cartridges", "sku": "OB12914", "description": "With all the quality of an Epson cartridge as a fraction of the price, the Q-Connect Epson Stylus Black Inkjet Cartridge offers a standard of excellence you would expect from a branded product without the hefty price tag. Designed to work flawlessly with your printer, this cartridge contains professional-grade ink that creates vivid and consistently stunning prints for the entire life cycle of the cartridge.", "pricecurrency": "GBP" }
<a href="#">#description</a>	null
<a href="#">#sku</a>	null
<a href="#">#url</a>	null
<a href="#">#brand</a>	{ "name": "Q Connect" }
<a href="#">#page_url</a>	<a href="https://webstore.astute.uk.com/q-connect-epson-t1291-remanufactured-black-inkjet-cartridge-c13t12914011---t129140/pi/OB12914-1612328-1.html">https://webstore.astute.uk.com/q-connect-epson-t1291-remanufactured-black-inkjet-cartridge-c13t12914011---t129140/pi/OB12914-1612328-1.html</a> ( <a href="#">xsd:anyURI</a> )

# Demonstration, Step 3 — View Transformation to a Specific RDF Notation, such as RDF-Turtle

```
CSV
Exit
1 @prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
2 @prefix xsd: <http://www.w3.org/2001/XMLSchema#> .
3 @prefix : <#> .
4
5
6 <#row_id> rdf:domain : .
7 <#name> rdf:domain : .
8 <#offers> rdf:domain : .
9 <#description> rdf:domain : .
10 <#sku> rdf:domain : .
11 <#url> rdf:domain : .
12 <#brand> rdf:domain : .
13 <#page_url> rdf:domain : .
14
15 <#row_id> rdf:range xsd:integer .
16 <#name> rdf:range xsd:string .
17 <#offers> rdf:range xsd:string .
18 <#description> rdf:range xsd:string .
19 <#sku> rdf:range xsd:string .
20 <#url> rdf:range xsd:string .
21 <#brand> rdf:range xsd:string .
22 <#page_url> rdf:range xsd:anyURI .
23
24 [
25 <#row_id> "0"^^xsd:integer ;
26 <#name> "Goldline Coloured Card White.Gcc3220 Pk25"^^xsd:string ;
27 <#offers> '{"category": "Paper", "sku": "329235", "description": "The Goldline Plain White Card uses heavy 210gsm card stock that is ideal for sturdy, long-lasting posters and artwork.'}'^^xsd:string ;
28 <#description> "null"^^xsd:string ;
29 <#sku> "null"^^xsd:string ;
30 <#url> "null"^^xsd:string ;
31 <#brand> '{"name": "Goldline"}'^^xsd:string ;
32 <#page_url> "https://webstore.astute.uk.com/goldline-coloured-card-whte-gcc3220-pk25/pi/329235-110250-1.html"^^xsd:anyURI ;
33 ].
34
35 [
36 <#row_id> "1"^^xsd:integer ;
37 <#name> "UNCONDITIONAL long shirt with centre back tail split in silver grey light tencel shirting"^^xsd:string ;
38 <#offers> '{"description": "UNCONDITIONAL SS16 long shirt with centre back tail split in silver grey light tencel shirting, features a concealed button placket and contrast black buttons * A"}'^^xsd:string ;
39 <#description> "null"^^xsd:string ;
40 <#sku> "null"^^xsd:string ;
41 <#url> "https://www.unconditional.uk.com/products/unconditional-long-shirt-with-centre-back-tail-split-in-silver-grey-light-tencel-shirting"^^xsd:string ;
42 <#brand> "null"^^xsd:string ;
43 <#page_url> "https://www.unconditional.uk.com/products/unconditional-long-shirt-with-centre-back-tail-split-in-silver-grey-light-tencel-shirting"^^xsd:anyURI ;
44 ].
45
46 [
47 <#row_id> "2"^^xsd:integer ;
```

## Demonstration, Step 4 — Query Knowledge Graph using SPARQL

With OSDS, you are only a single click away from generating a SPARQL query results page from any CSV document you've opened in your browser.

*Click on any Hyperlink for deeper exploration of the underlying Knowledge Graph!*

EntityID	count	EntityTypeID
<a href="https://linkeddata.uriburner.com/proxy-iri/35751b9cdd64b60f18eecbd4fdeee897b794cbdc">https://linkeddata.uriburner.com/proxy-iri/35751b9cdd64b60f18eecbd4fdeee897b794cbdc</a>	24	<a href="http://www.openlinksw.com/schemas/opltable#Row">http://www.openlinksw.com/schemas/opltable#Row</a>
<a href="https://linkeddata.uriburner.com/proxy-iri/35751b9cdd64b60f18eecbd4fdeee897b794cbdc">https://linkeddata.uriburner.com/proxy-iri/35751b9cdd64b60f18eecbd4fdeee897b794cbdc</a>	24	<a href="http://data.dws.informatik.uni-mannheim.de/structureddata/schemaorgtables/Product/samples/Product_csvsample.csv#class">http://data.dws.informatik.uni-mannheim.de/structureddata/schemaorgtables/Product/samples/Product_csvsample.csv#class</a>
<a href="http://www.w3.org/2002/07/owl#">http://www.w3.org/2002/07/owl#</a>	8	<a href="http://www.openlinksw.com/schema/attribution#DataSource">http://www.openlinksw.com/schema/attribution#DataSource</a>
<a href="http://data.dws.informatik.uni-mannheim.de/structureddata/schemaorgtables/Product/samples/Product_csvsample.csv#class">http://data.dws.informatik.uni-mannheim.de/structureddata/schemaorgtables/Product/samples/Product_csvsample.csv#class</a>	1	<a href="http://www.w3.org/2000/01/rdf-schema#Class">http://www.w3.org/2000/01/rdf-schema#Class</a>
<a href="http://data.dws.informatik.uni-mannheim.de/structureddata/schemaorgtables/Product/samples/Product_csvsample.csv">http://data.dws.informatik.uni-mannheim.de/structureddata/schemaorgtables/Product/samples/Product_csvsample.csv</a>	1	<a href="http://schema.org/CreativeWork">http://schema.org/CreativeWork</a>
<a href="https://linkeddata.uriburner.com/about/id/entity/http://data.dws.informatik.uni-mannheim.de/structureddata/schemaorgtables/Product/samples/Product_csvsample.csv">https://linkeddata.uriburner.com/about/id/entity/http://data.dws.informatik.uni-mannheim.de/structureddata/schemaorgtables/Product/samples/Product_csvsample.csv</a>	1	<a href="http://www.openlinksw.com/schemas/opltable#Table">http://www.openlinksw.com/schemas/opltable#Table</a>

# Demonstration, Step 5 — View Query Editor for OSDS-Generated SPARQL Query

The screenshot shows a web browser window with a SPARQL query editor. The browser's address bar shows the URL: `https://linkeddata.uriburner.com/sparql/?query=DEFINE%20get%3Asoft%20"soft"%20%...`. The query editor displays the following SPARQL query:

```
1 DEFINE get:soft "soft"
2 SELECT (SAMPLE(?s) AS ?EntityID)
3         (COUNT(*) AS ?count)
4         (?o AS ?EntityTypeID)
5 FROM <http://data.dws.informatik.uni-mannheim.de/structureddata/schemaorgtables/Product/sampl
6 WHERE {
7     ?s a ?o .
8     FILTER (CONTAINS(STR(?o), 'schema'))
9 }
10 GROUP BY ?o
11 ORDER BY DESC (?count)
12 LIMIT 50
13
```

The left sidebar of the editor shows a table with the following content:

EntityID
<a href="https://linkeddata.uriburner.com/proxy-iri/35751b9cdd64b60f18eecbd4fdeee897b794cb">https://linkeddata.uriburner.com/proxy-iri/35751b9cdd64b60f18eecbd4fdeee897b794cb</a>
<a href="https://linkeddata.uriburner.com/proxy-iri/35751b9cdd64b60f18eecbd4fdeee897b794cb">https://linkeddata.uriburner.com/proxy-iri/35751b9cdd64b60f18eecbd4fdeee897b794cb</a>
<a href="http://www.w3.org/2002/07/owl#">http://www.w3.org/2002/07/owl#</a>
<a href="http://data.dws.informatik.uni-mannheim.de/structureddata/schemaorgtables/Product/samples/Product_csvsample.cs">http://data.dws.informatik.uni-mannheim.de/structureddata/schemaorgtables/Product/samples/Product_csvsample.cs</a>
<a href="http://data.dws.informatik.uni-mannheim.de/structureddata/schemaorgtables/Product/samples/Product_csvsample.cs">http://data.dws.informatik.uni-mannheim.de/structureddata/schemaorgtables/Product/samples/Product_csvsample.cs</a>
<a href="https://linkeddata.uriburner.com/about/id/entity/http://data.dws.informatik.uni-mannheim.de/structureddata/schemaorgtables/Product/samples/Product_csvsample.cs">https://linkeddata.uriburner.com/about/id/entity/http://data.dws.informatik.uni-mannheim.de/structureddata/schemaorgtables/Product/samples/Product_csvsample.cs</a>

## What's Actually Going on Here?

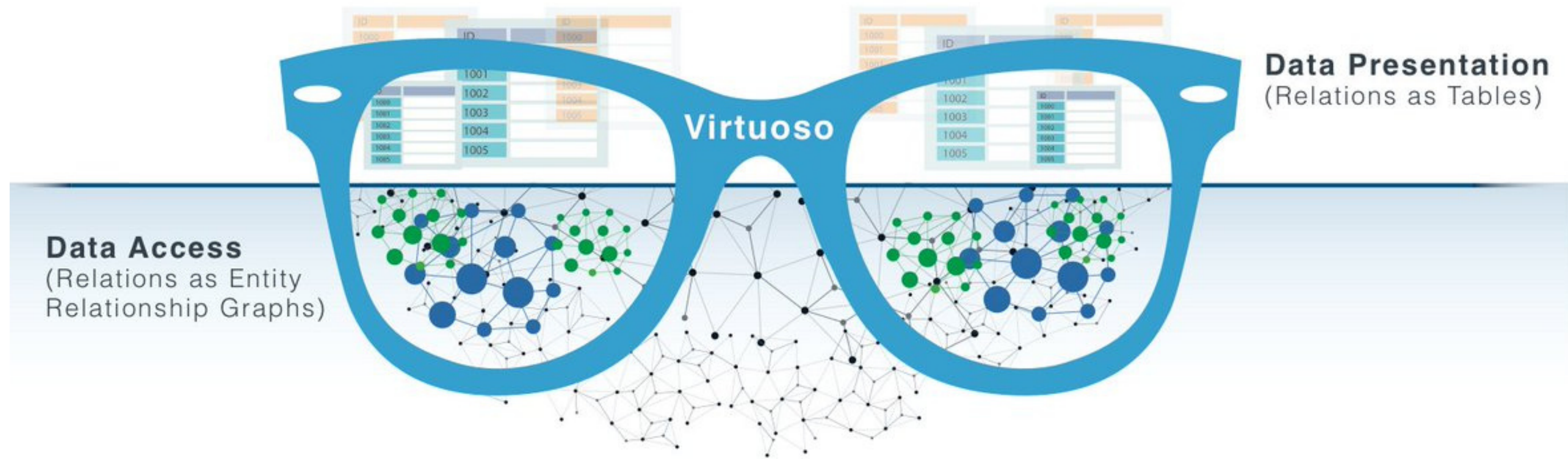
Virtuoso, our Multi-Model Relational Engine, handles Relations represented as Tables and/or RDF Graphs. Simply import or attach any CSV, ODBC, or JDBC data source, and Virtuoso does the rest!

### Fundamentally —

- Tables are powerful *visualization* tools for *data analytics*
- Graphs are powerful *navigational* tools for *query construction and optimization*

All this powerful functionality is packed into *one-click interactions* initiated from OSDS.

# Virtuoso HyperData “Context Lenses”



## How Do I Get Going?

- **OSDS Browser Extension** - [various options for installation](#)
- **Virtuoso On Premise** — Installer and Free 30-day Evaluation Licenses from our [Download Site](#)
- **Virtuoso Docker Container** — various containers from [Docker Hub](#)
- **Virtuoso Cloud** — Bring-Your-Own License (BYOL) and Pay-As-You-Go (PAGO) instances in the Cloud at [Amazon Web Services \(AWS\)](#), and [Microsoft Azure](#)



## ADDITIONAL INFORMATION

- [OpenLink Structured Data Sniffer](#)
- [Virtuoso Home Page](#)
- [Virtuoso Weblog](#)
- [Virtuoso Community Forum](#)